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THE OPERATIVE TREATMENT  
OF  
STRABISMUS

BY

FREELAND FERGUS, M.D.

SURGEON GLASGOW EYE INFIRMARY

FORMERLY OPHTHALMIC SURGEON TO THE GLASGOW ROYAL INFIRMARY.

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## ON THE OPERATIVE TREATMENT OF STRABISMUS.<sup>1</sup>

THE subject of squint is, from the nature of things, a complex one; the causes of it are various, and its forms are numerous; hence, it is not a simple matter to discuss, in a single night, the treatment of all its forms, nor shall the task be attempted. In the following remarks an endeavour will be made to deal with a few typical examples.

1. In certain persons the affection is the result of an error of refraction. This is especially true of concomitant squint occurring with hypermetropia, or with hypermetropic astigmatism, in one or in both eyes.

2. In others it is the result of an amblyopia in one eye. Instances of this are seen when the formation of an opacity of the cornea leads to strabismus, or when the affection is due to cataract of one lens, or other diseases seriously impairing the visual acuteness, as separation of the retina, optic nerve atrophy, etc. In these cases the deviation of the eyes is generally in the direction of divergence, although, for reasons which cannot here be discussed, there is occasionally convergence.

3. Then, again, it is sometimes due to paralysis of a single muscle or of several muscles in one or in both eyes.

4. In addition we must add to this catalogue those cases generally included under the name of heterophoria. These, in former days, were usually classed under the title of muscular insufficiencies. Most men who have studied the question are

<sup>1</sup>Read before the Glasgow Medico-Chirurgical Society, April, 1898.

agreed that, because the muscle supposed to be involved cannot, as a rule, be shown to be altered either in structure or in its origin and insertion, the name muscular insufficiency is, for the most part, a misnomer. The affection is now regarded as one of the innervation. Hence the new name heterophoria.

5. Closely allied to the amblyopic squints are those in which the optical conditions are such that one eye has not for ordinary distances useful vision while the other has. Thus, one eye may be emmetropic, the other myopic. As will be seen presently, there is in these cases no impulse towards binocular fixation, and hence there is squint.

We have, perhaps, in these remarks not included all forms of strabismus, but those mentioned are the important varieties, and are sufficient for our purpose.

Another classification of strabismus is possible, and at this stage probably advisable. Some cases are absolute, others are relative.

By strabismus is meant a want of symmetry in the visual axes of the eyes. Thus, when a person with this affection looks at a distance the optical axes of his eyes may not be parallel. When he looks at a near object one eye may be directed properly to the object, the other may not. It may, for example, converge too much, or it may diverge.

By *absolute strabismus* is meant that for no fixation point is there symmetry of the visual axes; by *relative*, that in some positions there is, and that in others there is not. The most familiar example of absolute strabismus is the concomitant form which is often associated with hypermetropia. Let the fixation object be placed in any position, then one eye is directed properly towards it while the other converges too much.

Of relative strabismus the most familiar type occurs in paralysis of an ocular muscle. Let us take, say, a paralysis of the left external rectus. Now, on looking to the left side there is no interference with the movements of the right eye. It can move perfectly towards the left. The left eye, on the other hand, cannot; it is restricted in its

movements towards the left, and hence, when the patient looks towards the left at a distant object there is convergence of the optical axes. But were the patient to look towards his right, then there might be neither undue divergence nor convergence, for the right eyeball would be chiefly under the control of its external rectus and the left for the most part under that of its internal rectus. Neither of these muscles is affected by the supposed paralysis, and hence, if a distant object is looked at there may be approximately parallelism of the optic axes.

Other important examples of relative strabismus are to be found in cases of what is called heterophoria. The example most easily understood is the variety called exphoria, and it may be in suitable cases demonstrated in the following manner. Let an ink line be drawn on a piece of paper, and let it be held vertically at a yard in front of the patient, as nearly as possible at an equal distance from each eye and at the height of the eyes. Most probably under these conditions the line will be seen singly. Let the test object now be brought nearer and nearer to the patient. The likelihood is that it will still be seen as a single line to a point much nearer to the eyes. At last, however, a position is reached which is the maximum of convergence, and for all nearer distances one eye follows the test object accurately while the other does not, but relatively, if not absolutely, deviates outwards. If there is fairly good vision in each eye a crossed diplopia ensues. This is a tolerably good method of measuring the near point of convergence, although a still better one is an illuminated slit or dot, as in the ophthalmodynamometer devised by Dr. Landolt.

This leads further to the remark that the treatment of any form of strabismus has for its ideal either the restoration of a disturbed binocular fixation, or else an aesthetic effect. In certain cases where there is no useful sight in an eye a patient may yet insist on treatment in order that an obviously disfiguring squint may be put right. In most of these cases a sufficiently good result can easily be obtained. Here is a case in point:—



J. D., aged 20, has a divergent squint of the left eye. It is found that the right eye is almost emmetropic and has very good visual acuteness. In the left there are eighteen dioptries of myopia; the patient can read No. 14 Jaeger with the left eye when the types are held at its far point. Such cases are not uncommon. Now, any treatment here must be for the sake of appearance, for the optical conditions are such that even with careful correction binocular fixation could not extend beyond a very narrow limit. For suppose the correction to be made. Before one eye there would be placed a piece of glass with little or no refractive power; before the other a strong concave lens. Now, when the patient looks straight in front of him at a distant object there might possibly be binocular fixation, but for every other position of the eyes it is almost impossible, owing to the prismatic and cylindrical effects which are consequent on the oblique refraction through the periphery of the concave lens. When, however, there is a fair amount of vision in each eye, then the proper object of treatment should be to secure binocular fixation for all possible points. Yet how few think of this. When a parent brings her child to have a squint seen to, or a medical man sends a patient to a specialist for the same purpose, it is in the vast majority of cases for the aesthetic result of having the squinting eye put apparently straight; rarely is it with the rational purpose of the restoration of binocular fixation. Yet this function is an important one, for, as is well known, it is the most important factor in the unconscious estimation of the third dimension. While, therefore, appearance is a thing not to be despised, our ultimate end in all operative work in strabismus should be the restoration, when possible, of binocular fixation. It is the object of this paper to show that this result cannot, in a satisfactory manner, be brought about by tenotomy, but that the best method of operating is by advancement.

We must here insist on the necessity of every case being thoroughly examined. If this be done, then the surgeon obtains a clear idea of the conditions with which he is dealing, and may, in certain cases, arrive at a satisfactory



conclusion as to the cause of the affection in the particular case which he is examining.

In times gone past tenotomy for concomitant squint was often performed without any examination of the functions at all, or, at most, the refraction of the eyes was measured and the visual acuteness. But in many cases no attempt was made before interference to measure carefully the angle of the squint, and no investigation was made as to the field of fixation nor the function of convergence. Had these matters been inquired into, I am satisfied that the death knell of tenotomies, except under special circumstances, would have been sounded long before Landolt's time. It is because he has for many years, with an assiduity and care worthy of all praise, investigated cases of squint that we are now in a better position than formerly to treat the affection on rational principles.

Let us narrow our inquiry in the meantime to the crux of the whole question—viz., the treatment of convergent strabismus as it occurs along with hypermetropia or hypermetropic astigmatism. If we can make out a good case for advancement of the external recti, instead of tenotomy of the internal, the worst of the fight will be over, for it is a comparatively easy task to extend the argument to most of the other forms of the affection.

From the days of Donders onwards, much has been written as to the etiology of that variety of convergent squint which is called concomitant. He it was who first pointed out its frequent association with hypermetropia, or with hypermetropic astigmatism, and gave a rational explanation of the condition. For my own part, it seems that his explanation still holds good. At the risk of repeating what must be familiar to almost everyone who has taken a course of modern physiology, we give a brief summary of his views.

In ordinary circumstances, for any act of binocular fixation two closely allied functions are called into play—viz., convergence and accommodation. Thus, given a person who is possessed of good visual acuteness in each eye, and whose refraction is approximately emmetropic, when he looks at a

distant object he neither accommodates nor converges; both functions are in abeyance. If now a point 2 metres away is fixed, the person both converges and accommodates for that distance. If the point be 1 metre away, then the accommodation and convergence necessary for the new distance are at once brought into play. If the test object is now brought nearer and nearer, two points are obtained. One of them marks the nearest limit of the power of accommodation; this varies with the age of the patient and with other circumstances which need not detain us at present. The other is the near limit of the convergence, and for the most part varies with the innervation of the internal recti muscles.

Such is the usual condition, and it will be noticed that for all ordinary distances the two functions progress *pari passu*. Be it observed that in normal conditions every act of accommodation means also a certain definite act of convergence. Now, in hypermetropia matters are different. Here distant vision requires an act of accommodation although not of convergence. The one function is called into play before the other, and as the object is brought nearer, the accommodation is to a certain extent more used than the convergence. But we have just seen that if a given amount of accommodation is used in emmetropia, then there must also be employed a given amount of convergence. Therefore, if there is to be in hypermetropia binocular fixation, this involves that the two functions are more or less disassociated from each other; in other words, that the act of accommodation is not accompanied by a corresponding act of convergence, but by an effort less in amount.

It is probable that it is this interference with the normal relationships existing between the two functions which is in many cases the cause of ophthalmic headache. Thus, in hypermetropia we find that when each eye has a good visual acuteness the patient sacrifices his comfort in the interests of binocular vision, and forces himself to use less convergence than would otherwise be required for the amount of accommodation used. If, however, defective sight exist in one



eye, then there is no longer any need of disturbing the normal relationships of the two functions, because from the defective vision it is impossible for the patient to have the natural perception of the third dimension. In many cases, it seems likely that the defective vision found in a squinting eye is the *propter hoc*, not the *post hoc*. No doubt in some subjects other influences are at work, for we occasionally, although rarely, find concomitant squint in persons in whom both eyes are possessed of excellent vision. In this connection it is well to remember that some authors have tried to establish a connection between rickets and squint. That is, however, a matter beyond our present inquiry. What is insisted on is that where in hypermetropia, binocular vision is impossible owing to one eye being defective in vision, then the effort of accommodation is generally accompanied by its proper amount of convergence. In other words, in these circumstances we are liable to have convergent squint.

In certain cases this squint is alternating—*i.e.*, it appears first to affect one eye, then the other; but in most, it sooner or later becomes located apparently in one. I say apparently, for it must be kept in mind that concomitant squint is in reality always a bilateral affection. For example, when a hypermetropic patient fixes a distant object, an amount of accommodation is used sufficient to overcome or correct the hypermetropia. Along with this there is the corresponding amount of convergence, and the two eyes assume a definite convergence towards each other. The distant object is not then in the line of sight of either. To rectify this, while the two eyes still retain their relative convergence to each other, one of them, usually that with the best visual acuteness, is turned towards the object which the person wishes to see, the other therefore apparently converges all the more; for the two maintain the same relative convergence. There is a certain tension of the innervation of both internal recti.

Such, briefly stated, is the theory of the origin of concomitant strabismus which, though it must under special



circumstances be modified, appears to me to explain the greatest number of cases.

This paves the way for the discussion of the treatment of concomitant squint. That treatment divides itself into—1, Orthoptic; 2, Optical; 3, Operative.

1. The chief difficulty which the surgeon experiences in the scientific treatment of squint is the impatience of his patients, or more especially of their guardians. A young child has strabismus, and its parents or other guardians become anxious that the defect should be put straight without delay. Thus, the surgeon is rarely allowed to spend that care and time over the treatment of his patient which is requisite for orthoptic exercises. Moreover, there is always the pressure of school work, so that it is next door to impossible to have a young person subjected to this important line of treatment. In young adults, however, something of the kind may generally be attempted. No statement of details can be given here, but in general terms it may be said that the lines to be followed are, first, by regular and patient exercises to excite what vision is possible in the squinting and amblyopic eye. If we succeed in getting fair vision in this eye, the next effort should be devoted to arousing in the patient the sense of binocular vision—*i.e.*, the sense of perspective. Probably the only method of doing so is by long and patient exercise with a good stereoscope. Any well devised stereoscope will do. The one which I personally use is that of Dr. Doyne, but I do not think it has any special advantages over any other form. For the early exercises it is well to put on one side of the stereoscope the upper half of a picture, and on the other the lower half, so that the patient's efforts may be directed to combining them into one.

2. As regards optical treatment, we must, of course, correct all errors of refraction. In olden times there was a haphazard way of fitting every case of concomitant squint with spherical + 3 D. It was said that every child who had a concomitant squint must have a hypermetropia of 3 D. This simply illustrates how very carelessly examinations were made at that time. For although it be true that in very many cases there

is that amount, still in others there is not. In fact, not infrequently concomitant squint is found where one eye has even a somewhat low error of refraction, such as 2 D of hypermetropic astigmatism, and the other is nearly emmetropic. I have seen several such cases. It would simply be the height of absurdity to put a pair of + 3 D glasses on a case of that kind.

A correction, no doubt, should be made, but it ought to be as careful and as accurate as possible; otherwise it is worse than useless.

Optical treatment also includes proper exercise by prisms. Where, as a result of efforts to encourage vision in the squinting eye, the patient has been made conscious of a diplopia, they are of use in helping the patient to unite the images into one.

Under the heading of optical treatment the installation of mydriatics may almost be included. These act orthoptically by paralysing the power of accommodation, and thus allaying the effort of convergence. In whatever way they act there is no doubt of the clinical fact that, given a case of squint with little difference in the error of refraction and with a fair amount of vision in each eye, a course of mydriatics with correction of refraction errors will, without further treatment, often restore binocular fixation.

3. But I wish to-night to dwell especially on the operative treatment; for within the last few years my own opinion, in common with that of many better able than I to form one, has undergone a radical change. For a considerable time I have operated on all cases of divergent squint by advancement. In my earlier days I operated on a few occasions for divergent squint, or for what was called insufficiency of the internal recti, by tenotomy alone. For many years, however, I have, in common with most others, invariably operated on divergent squint, absolute or relative, by advancement of one or both internal recti. For some time back I have operated on convergent squint only by the same method, and have given up tenotomies almost entirely. My endeavour to-night is to justify, if possible, this important change.



I shall try to show—1, That the operation is more rational than tenotomy; 2, that it is easily performed; 3, that the results are quite as successful; 4, that it does not produce the disfiguration similar to that produced by tenotomy.

1. Whatever theory may be held as to the origin of concomitant squint, careful examination of the field of fixation with an ordinary perimeter will show that the ultimate result is that in most cases the external recti muscles are extremely defective in function. As a rule, the internal recti do not seem to have a stronger action than normal. As a matter of fact, in a very fair proportion of cases they are weaker than usual. Yet, in most cases the strength of the internal recti does not differ from what is generally found. This is not merely an opinion, but is a matter of fact.

Now, if an attempt is made to rectify this state of affairs by tenotomy, apparent straightness is only obtained when the converging function is made as weak as the diverging was before. Not till then will the eyes easily assume the parallel position for distance, although it is freely admitted that this parallelism for distance can be obtained under favourable circumstances. That it is so in some cases is, however, more by good luck than by good guidance. But what then? Most acts of accurate vision require a certain amount of convergence. By tenotomy, to a very large extent indeed, this power of convergence is destroyed. You have not strengthened the diverging power by sacrificing the converging; all you have done is to weaken the convergence. Hence, what is known as the positive part of the range of convergence is much lessened in extent, and as a natural and necessary sequence the near point of binocular fixation is at a considerable distance from the eyes. A heterophoria is artificially established. There is no possibility of binocular fixation for near distances. In illustration let an easy example be taken: if a man is to read a book at 16 inches binocularly, he must accommodate at least to 16 inches, and converge to the same distance. Not only so, but as no function can be used to its full extent with comfort to the individual, he must be able to accommodate to a much



nearer point, and to converge to one still more close. In both cases there must be a large reserve.

If, then, by tenotomy you have greatly reduced this reserve, or annihilated it altogether, comfortable binocular vision is no longer possible. Under such circumstances it is not at all infrequent to find that the patient gives up the effort and allows one of his eyes, by preference the one less useful for sight, to deviate outwards. This deviation at first may only be for near objects, but ultimately it is always present. The previous convergence is in the worst cases turned into an absolute divergence. Within the last year I have carefully examined a number of cases which had previously been operated on by myself or by others for concomitant squint by the method of tenotomy. In only two of them have I found a satisfactory near point of binocular fixation; in all the others the positive range of convergence was much diminished, and in some it was absent altogether. In such cases it is usual to say that the operation has been a bad one; that the surgeon has cut too much. In some cases this charge may be true, but in the majority it is not. The absolute or relative divergence is nothing less or more than the necessary physiological sequence of the altered conditions of the internal recti.

Particularly is this ultimate divergence liable to occur in cases which have been operated on under the influence of a general anæsthetic. In these cases the surgeon is apt to divide the attachments of the tendon to the capsule of Tenon too freely. In very many cases operated on under the influence of chloroform or ether I have found a marked divergence. It is, so far as my experience goes, the exception to find the eyes straight even for distant vision.

There is, however, another side to the question. In many cases the tenotomy does not bring the eyes even approximately straight for distance, but still leaves a very marked convergence. That is a clinical fact which all who are not the merest novices will admit. In many such cases the explanation is that the diverging power is so weak that even by tenotomy the convergence cannot be weakened to such an extent as to

allow the eyeballs to assume the parallel position for distant fixation. Many of these cases are explained by a marked amblyopia in one eye, which involves that there is no impulse towards binocular fixation.

In my student days it was said that certain cases of convergent squint were associated with weakness of the external rectus muscle of the squinting eye, and even at that time it was a rule laid down for our guidance that unless the external rectus could draw the eye beyond the middle line advancement of the external should be performed with tenotomy of the internal.

In a very fair proportion of cases a tenotomy does not seem to make any very marked difference in the relative positions of the eyes.

From the above it will be apparent that tenotomies are somewhat haphazard experiments, which sometimes succeed, but at other times do not.

The operation by advancement, on the other hand, is more rational, in so far as it does not attack a function which is more or less in a normal condition, but is directed against the abnormality of function. It is an effort to restore impaired function, not to impair healthy function. That statement by itself goes a long way to prove this operation to be more rational than tenotomy. But, further, in the vast majority of cases there is no reason to apprehend a resulting divergence. I have performed the operation in a large number of cases, and in one only has there been an ultimate slight divergence. That arose from my carelessness, and a little more strict attention to the rules which I have formulated for my own guidance would have prevented this mishap. The case was that of a young lady who had been operated on by tenotomy for convergent squint in childhood. When I saw her, notwithstanding the tenotomy, there remained a convergent squint of not less than  $20^{\circ}$ . The examination of the field of fixation showed great diminution in the functions both of the internal and external recti.

As a rule, in concomitant squint both external recti must be advanced. This, perhaps, ought not to be done when the



convergence is deficient. In the particular case here referred to it unquestionably was, and that probably owing to the tenotomy, which, however much it had impaired one internal rectus, had not even apparently removed the squint nor strengthened in any way the external muscles. In future, when examination of the field of fixation shows marked defective power in the internal recti, I shall not advance both muscles at the same time. This is the only case in which there has been even the slightest divergence. But what of that? It does not matter; this slight divergence is due to the destroyed convergence, and all that is required to put it right is an advancement of the previously divided internal rectus.

Speaking generally, however, I find it to be the rule that the operation should be performed on both external recti when the strabismus is severe, and when the internal recti are nearly of normal strength.

The advantages, then, which may be claimed for the operation are—(a) It does not, except from the carelessness of the operator, lead to divergence, and if it should, then the defect is easily remedied by advancement of the internal rectus; (b) it does not in the least interfere with the function of the internal recti, so that if their power was good before, it remains good and the patient may have an excellent range of convergence.

2. In the next place, the operation is easily performed. So far as that goes, a few drops of a solution of cocaine introduced into the capsule of Tenon render it all but painless, so that only for young children or for timid and nervous persons is a general anæsthetic required. The pain is reduced to a minimum if the patient during the operation is made to look in such a way as to relax thoroughly the muscle which is being operated on. *Thus, if the right internal rectus is being attacked, the patient should be made to look to the right side.* This is an important point.

That the operation is simplicity itself is proved by the fact that an internal or external rectus muscle can with the utmost ease be advanced within a period of ten minutes. I do not



intend to trouble my audience with the details of the operation, for I have already described the manner in which I perform it in the *Ophthalmic Review*. The method which I follow differs but little from that detailed by Mr. Swanzy in his text-book. The operation presents no difficulty whatever, nor is it any more dangerous than tenotomy. It is true that I have seen this latter operation followed by acute orbital cellulitis. Such a result I have never seen with an advancement. In any case, however, in which there is redness of the conjunctiva, it is well to follow the rule which I have adopted in all doubtful cases—viz., to bandage the eye with sterilised cotton-wool, and to cultivate any discharge collected thereon before operating. By so doing, the surgeon may be warned of danger.

3. Mention has already been made of the fact that a tenotomy sometimes does not seem in any material way to lessen the convergence. It is but right to state that occasionally with an advancement the same thing occurs. Even after the advancement of both external recti there may remain a slight convergence. Such cases are, however, rare. When this happens, if each eye is possessed of a fair amount of vision, our efforts should be directed to such orthoptic exercises as will stimulate the patient to binocular fixation. In most of these cases a perfect result, so far as straightness of the eyes is concerned, is ultimately attained, and let it be remarked that it is attained without any sacrifice of the power of convergence. When, therefore, the eyes become straight, there is a possibility of the patient having a satisfactory near point of binocular fixation if not of vision.

4. As to the element of disfigurement, there can be no doubt as to which is the preferable operation. Almost invariably it is possible to tell by inspection an eye which has been submitted to tenotomy, for it presents three marked features—viz., the inner canthus is somewhat distended, the caruncle is shrunk, and there is a certain amount of protrusion of the eyeball. The eyeball may be said to rest at the base of a surrounding muscular cone, which keeps it in position. If, therefore, at any point these enclosing muscles

become detached, the eyeball tends at that point to protrude, and as a matter of fact it often does so. Sometimes this defect exists to such an extent as to give an appearance of one of the lesser degrees of exophthalmos.

Such deformities are entirely unknown after advancements. There never is that dilatation of the inner canthus which is so troublesome in tenotomies, and for the avoidance of which so many proceedings have been devised without any very satisfactory results. The only deformity which results from an advancement is the formation of a small granulation tumour in the wound, which can easily be removed.

## OPERATIONS FOR SQUINT BY ADVANCEMENT.<sup>1</sup>

IN a communication made some time ago to the Medico-Chirurgical Society of Glasgow I endeavoured to point out the many advantages of muscular advancement over tenotomy in the treatment of all forms of strabismus. The cases there chiefly discussed were those of concomitant convergent strabismus, and the objections advanced to tenotomies in the treatment of this affection were as follows:

1. Concomitant convergent strabismus in the vast majority of cases can be shown to be associated with a defective action of the external recti, and not with an excessive action of the internal recti. If this be so, it is more rational to attack what is defective than to interfere with a function which is not impaired, to strengthen the power of relative divergence without impairing the convergence.

2. By performing advancement we are the more likely to restore binocular vision. The ideal end of all operations for strabismus is the restoration of binocular fixation. No doubt in many cases this ideal cannot be attained, and the most that sometimes can be expected is the aesthetic effect of the reduction of an obvious deformity.

3. Tenotomy very often causes deformity. Thus generally after a tenotomy, the inner canthus will be found to be widely dilated, and the movement of the eyeball in the direction of

<sup>1</sup>This paper contains the substance of a lecture given in connection with a Lantern Demonstration to the Glasgow Medico-Chirurgical Society.



the divided muscle much impaired, while along with these changes there is a certain amount of exophthalmos.

Occasionally also after tenotomy there is marked divergence. Particularly is this true when the operation has been done during the administration of a general anaesthetic. It occurs in a very considerable percentage of cases, and in the hands of even the best operators. A hideous divergent squint after tenotomy is not always the result of bad operating, although it is often supposed to be so, but in many cases is a natural sequence of the operation selected.

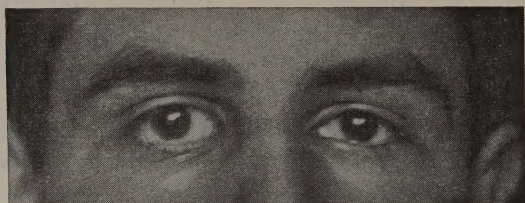
4. In many cases the squint is not apparently diminished by the tenotomy. No doubt accurate and careful measurements would reveal a certain diminution in the angle of the squint, but the disfigurement caused by the squint is not appreciably lessened. Such were the objections which I advanced to tenotomy for squint.

It is my present purpose to give a few diagrams of certain cases before and after operation. These have, possibly with one exception, been made from negatives taken by myself. The earlier negatives were made with an ordinary camera, but the more recent with the apparatus devised by Maddox.

It is impossible to teach any part of surgery clinically by diagrams, and no competent teacher will attempt it. What would be thought of a surgeon who, teaching clinically, instead of showing actual cases and operations, contented himself with mere pictorial representations? Hence I regret that in the present communication I have to fall back on so crude a method as the exhibition of photographs. It is impossible that by the inspection of these anything like clear information can be obtained. It is impossible on a lantern slide to measure fields of fixation or the range of the convergence. Moreover, a picture can never reproduce nature. As thrown on the screen, however, these pictures have one advantage; they are considerably magnified, so any defects are more easily seen and good results more readily identified.

Before any absolute conclusion can be drawn as to the eyes being placed bilaterally symmetrically, it is necessary to have

the patient before us for examination. The corneal reflex as seen in pictures is no doubt a very fair criterion, but it is not an absolute one, in so far as it gives no indication whatever as to the axis of vision. It is, however, the only one available for my present purpose.



E. H.

The first picture is that of a lad, E. H., aged about 18. The present negative was made only a few days ago. Eight years ago, that is when the patient was aged ten, I performed a tenotomy of his right internal rectus. The operation was done under chloroform. Two obvious defects at once strike the observer.

(a) The inner canthus of the right eye is found to be extremely wide. Measured on the picture it is found to be about one-third as wide again as the other canthus. Hence there has been produced an unsightly deformity.

(b) It is apparent from the picture that the right eye is rotated slightly out or the left slightly in. The position of the patient at the time of being photographed was distant fixation as nearly as possible in the line of the camera lens. The left eye, being the better, is the one used for fixation, and the right is allowed to assume its natural position—in this case one of actual divergence. The distance between the inner margin of the right cornea and its own reflex is less than the corresponding distance on the other eye. Moreover, the distance between the inner margin of the cornea and the inner canthus is appreciably greater on the right side than on the left. There is, as a matter of fact, a divergence of several degrees as measured on the patient.



The condition of the patient at present is,

Right Sph. +3, cyl. +1, axis horizontal, V.A. =  $\frac{2}{60}$ .

Left Sph. +4, V.A. =  $\frac{2}{60}$ .

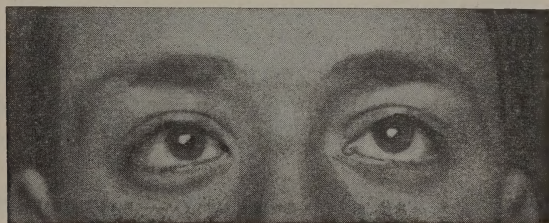
It may, of course, be said that this proves nothing except that the operation was bad. As regards the operation itself, it was a simple tenotomy, the division being restricted as much as possible to the tendon of the muscle. Dilatation of the inner canthus is even in the hands of the most celebrated operators a not infrequent occurrence, and none of the numerous procedures which have been invented for its prevention seem to be of the slightest avail.

As regards the divergence, that is a condition which I have not seen following any amount of advancement for the cure of strabismus convergens except in one case in which tenotomy had previously been performed. This case has already been mentioned in my previous paper.

A result such as has been obtained here renders binocular fixation, to say nothing of binocular vision, impossible, and although it lessens the unsightliness of the original condition still leaves much to be desired from an aesthetic point of view.

On proposing to operate for convergent squint, a fear is often expressed that after the operation the patient will squint outwards. This is a popular opinion, but not a delusion, for with tenotomy it frequently happens.

The second case which is shown is one in which the operation by tenotomy has not removed the defect.



J. P.

J. P., presently aged 17, was subjected to the operation of tenotomy of the right internal rectus fully four years ago. This photograph was taken after the operation with the



patient directly facing the camera, with distant fixation as nearly as possible in the axis of the lens of the camera.

On careful examination it is found that there are still  $15^\circ$  of convergent strabismus as measured on the perimeter arc. That, of course, is perhaps not the actual amount of squint, but is approximately correct. The patient was found to be so amblyopic that the attempt to measure the true amount of squint by means of prisms or by projection had to be abandoned.

The following notes were made in this case:

Vision of right eye = fingers counted at 18 inches.

Vision of left =  $\frac{2}{20}$ .

Right eye—hypermetropia of about 2.5 D with astigmatism of 1.5 D against the rule. These figures were estimated with the ophthalmoscope and ophthalmometer.

Left eye—nearly emmetropic.

The fundus in each eye looks perfectly healthy except that in the right the vessels are slightly tortuous. On examining the photograph it will be seen that the right eye is much nearer the right internal canthus than the left eye is to the corresponding canthus. The corneal reflex of the left eye is in front of the pupil, while that of the right is displaced slightly outwards—more of the pupil is seen.

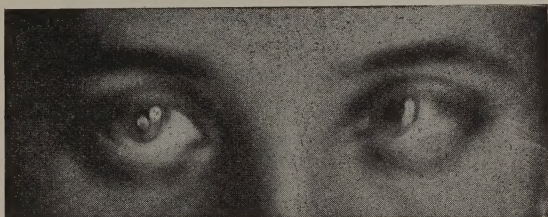
These two cases typify the worst defects of tenotomy; in one there is divergence, in the other convergence. Both no doubt can easily be remedied by advancement of an internal and an external rectus respectively. In the case of E. H. it is probably advisable, for there is a fair amount of vision in each eye, but the other case may be left alone, for the result at present has so much improved the apparent defect as to give satisfaction to those who examine the patient only casually.

The next case, Miss P. L., *act.* 21, presents some features of special interest.

This patient had squinted ever since she was two years of age. The affection was supposed to have supervened on her having received a fright.

The vision in each eye was equal to  $\frac{2}{20}$  letters.

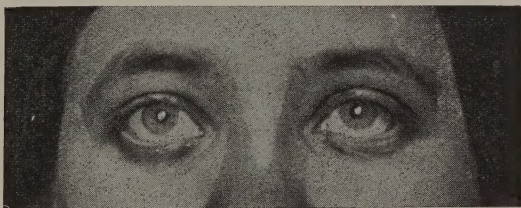
The amount of squint measured by projection and sexagesimal (not metre) tangents was nearly  $20^{\circ}$ . The right eye alone was used for fixation, although at an earlier age the affection seems to have been alternating. Examination of the fields of fixation showed that of the right to be in all respects normal. The test-object used was a very small letter moved round the arc of a Priestley Smith's perimeter. The right eye



Miss P. L. before operation.

was found to move both to the right and to the left in a perfectly normal manner. On the other hand there was very defective action in the rotation of the left eye towards the left, although the rotation of this eye towards the right was perfectly normal.

As was to be expected in a case in which the vision was so good in either eye, this patient had at times diplopia.



Miss P. L. after operation.

Little need be said about the photographs of this case except that in both the patient was turned full face to the camera, and that the fixation was for distance. Unfortunately the view taken before operation has not been well focussed, but it shows the squint quite plainly.

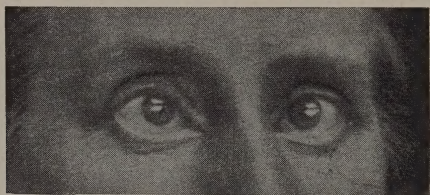
The external rectus of the left eye alone was advanced.



Fourteen days afterwards the stitches were removed. The patient has now no diplopia, and she has binocular fixation to about four inches from her nose.

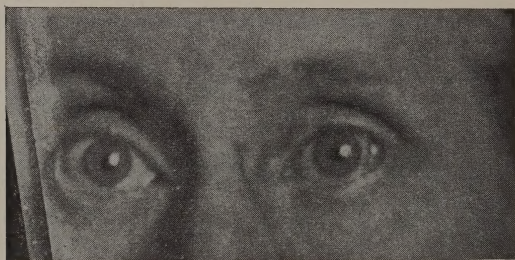
The next case, Mrs. M., is even more striking.

This patient was operated on in another town for convergent strabismus some years ago. The operation selected was teno-



Mrs. M. before advancement.

tomy of the left internal rectus, and it was twice performed on the same eye. Now, the surgeon who operated on this patient is a man of very high reputation as a practical surgeon. It would be the height of nonsense to suppose that an operation performed by him would not be thoroughly and efficiently done. Yet the final result was that the patient was left with a most disfiguring amount of convergent strabismus.



Mrs. M. after advancement.

No blame whatever can be attributed to the surgeon in this case by any fair-minded person; at any rate not at the time at which the operation was performed, for it was long prior to the advocacy of advancements at all.

Looking at the photograph of Mrs. M. before advancement it is obvious that the axes of the two eyes meet at a very



short distance in front of the patient. Yet at the time at which the exposure was made the fixation was for a great distance (much more than 20 feet). The patient was placed somewhat obliquely relatively to the camera, but still the condition can be realized by careful examination of the picture. The convergence remaining after the performance of two tenotomies was, as measured by the perimeter, about  $35^{\circ}$ .

In this case the advancement of one external rectus muscle, the left, sufficed to bring about the improvement shown in the second photograph. When this photograph is critically examined, it will be seen how symmetrical the corneal reflex is on each eye, the fixation being for a great distance. Only one muscle was advanced. As a rule I advance both external recti for convergent squint, and that at the same time, but in this case a careful examination of the field of fixation before operation showed the functions of the internal recti to be seriously impaired. A somewhat large clinical experience has led to the conclusion that as a rule a satisfactory result is only obtained when both external recti are advanced. Only once in a great number of cases has this resulted in divergence, but in that case this slight defect was easily overcome by advancement of the internal rectus which had previously been divided, and an excellent result was ultimately obtained.

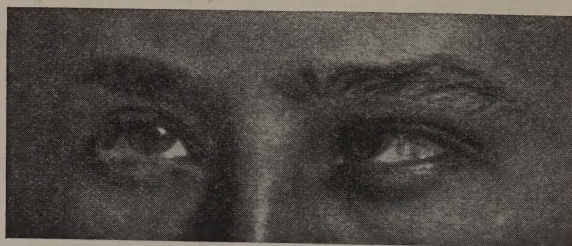
The visual acuteness of the right eye was  $\frac{6}{8}$ , with a hypermetropia of 3.5 D; the left eye was very amblyopic and the hypermetropia amounted to 4 D as estimated by the ophthalmoscope.

The next case is one which well illustrates the advantages of double advancement, although, for reasons which I cannot now recall, the two eyes were operated on at an interval of a week. Speaking generally, however, it may be said that the double operation should almost invariably be selected.

N. L., a lad aged 16 years, had a strabismus convergens of a most marked type. Judged by the ordinary methods of measurement it exceeded  $40^{\circ}$ . Notwithstanding this extreme amount the vision in both eyes was nearly normal, viz.  $\frac{20}{30}$  in each.

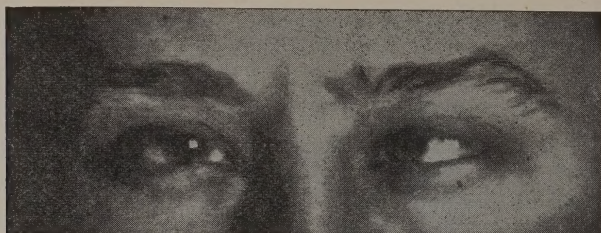
The diagrams require little explanation.

The first of the series represents the patient before he



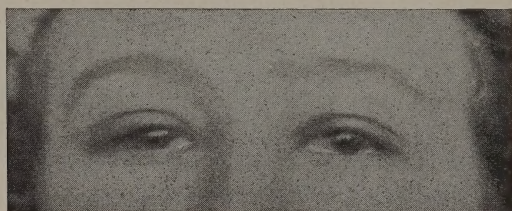
N. L. No. 1

was operated on at all. The second was taken after the advancement of the left external rectus, and shows little



N. L. No. 2.

or no improvement, and the third is the final result after the right external rectus had also been advanced.



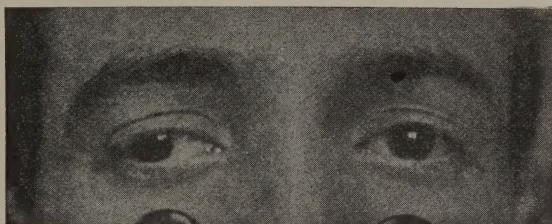
N. L. No. 3.

It has already been pointed out that, in many cases, tenotomy still leaves a marked convergence. It is but right to state that advancement occasionally does the same thing. It does so, however, much less frequently than tenotomy,



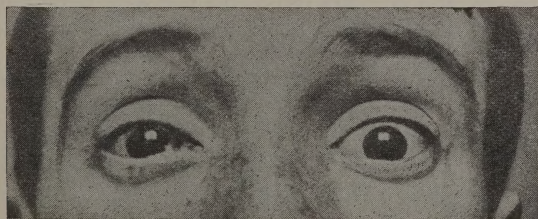
and this disappointing condition almost never occurs if both external recti are simultaneously advanced. Many more equally striking photographs could be shown of cases operated on for convergent strabismus, but these would be almost without exception a mere repetition of those already given.

Turning now to cases of ordinary strabismus divergens, I find that the results are equally good. I do not know in the whole range of ophthalmic practice a more satisfactory operation than advancement for divergent squint, unless it be in certain cases the same operation for the relief of asthenopia due to heterophoria.



J. R. T. before operation.

The two cases selected for demonstration are the first that came to hand, and illustrate all the important points.



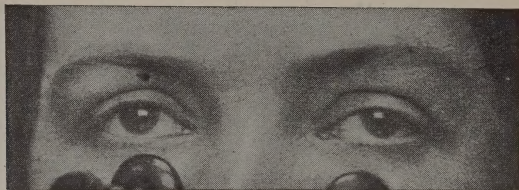
J. R. T. after operation.

J. R. T., aged 16. Patient suffered from divergent squint, the amount of deviation being between  $15^{\circ}$  and  $20^{\circ}$ . Vision in the right eye without any correction was rather less than  $\frac{20}{200}$ . On examination it was found that there were about 8D of myopia in this eye, and subsequently to operation he was ordered a concave spherical glass of that strength.



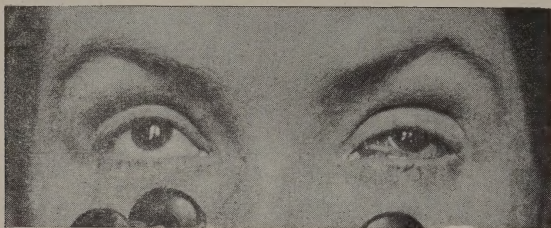
The left eye had, without correction, vision =  $\frac{20}{40}$ . When fitted with a weak concave cylinder the vision was  $\frac{20}{20}$  easily.

One operation only was performed, viz., advancement of the internal rectus muscle of the right eye. This was done on the 10th of April, 1899, and the patient was dismissed on the 1st of May following. A final note was made that the eyes were perfectly straight, and that the near point of binocular fixation was four inches from the nose. The test employed for binocular fixation was the simple one of covering the eyes alternately and watching for any movement of readjustment when a near point was fixed.



M. M'L. before operation.

Only one word of explanation requires to be made as to the photographs. In both the fixation was for distance. The altered appearance in the second is due to the fact that the patient was required to raise his eyebrows as much as possible in order to get the corneal reflex on the eye which had been operated on.



M. M'L. after operation.

M. M'L., aged 28. This patient had a divergent squint which was said to have been present since early childhood. The angle of squint when admitted to the hospital was found to be about  $15^\circ$ .

The vision in the right eye was  $\frac{2}{5}0$  without any correction of errors of refraction, and that of the left was  $\frac{2}{7}0$ .

An examination of the fields of fixation showed that there was distinct limitation in the movement of the left eye towards the right side. The patient was dismissed twelve days after advancement of the left internal rectus, with the eyes quite straight, and with a near point of binocular fixation at seven inches from her face—about six metric angles of convergence.

These cases are only samples of a large number which might have been given. In the Glasgow Eye Infirmary alone I have in the course of the last four years performed the operation of advancement no fewer than 130 times. In no case has there been any trouble in the operation itself, except in one in which the stitches gave way on the day following the operation. Even in that case, however, ultimately a good result was obtained by subsequent operation. No eye has been lost, and there have been no cases of tenonitis.

Silk sutures are in the main to be preferred to catgut. If properly prepared by immersion in 1-20 solution of carbolic acid for a prolonged period, they can be kept in the conjunctiva for an indefinite length of time without causing any inflammation. The explanation possibly is that the epithelium grows into the substance of the thread, completely preventing any septic material finding its way along it into the tissues.

In conclusion, it may be said that before any operation is undertaken, or indeed even contemplated, the patient should be thoroughly examined as to refraction, fields of fixation, and positive and negative ranges of convergence. Without a thorough inquiry into the nature of the case, any operation must largely partake of the nature of a haphazard experiment.















